Binary stellar evolution and transient emission

AST3100 Astrophysical Transients: Problem Set 2 (due: 2022 December 8)

We will use COSMIC, a Python library to simulate binary stellar evolution, to investigate the binary stellar evolution of a binary star of your choice and its ability to produce transients related to its binary evolution.

To install COSMIC, follow the instructions here: `https://cosmic-popsynth.github.io/docs/stable/install/index.html`

Examples of how to evolve a binary are documented here: `https://cosmic-popsynth.github.io/docs/stable/examples/index.html`

Try out one of the examples and have a look at the output of the plotting function and how the values are relevant for potential transient emission.

Details on how COSMIC works can be found in this paper: `https://ui.adsabs.harvard.edu/abs/2020ApJ...898...71B/abstract`

Another potentially useful reference is this brief review on binary population synthesis in general: `https://ui.adsabs.harvard.edu/abs/2018arXiv180806883I/abstract`

Pick a type of binary that goes through a period of mass transfer in its life and run a set of simulations to answer the following questions:

- Sketch the different stages of the evolutionary history of your choice of binary star and link these to the COSMIC output. Use the equations discussed in class to check the changes of the orbit and masses.

- How long do the episodes of mass transfer last? Are they stable or unstable?

- At what stages in the life of your binary could it produce transient emission?

- If you change the initial conditions of the binary (e.g., the masses, metallicity, ellipticity, rotation – pick one to investigate), how does it change the outcomes of the binary evolution (i.e., updating `InitialBinaryTable`)?

- How does the outcome for your binary depend on tunable parameters of the (binary) stellar evolution prescriptions in COSMIC such as common-envelope efficiency (i.e., updating `BSEDict`)?

- *Bonus*: Our understanding of the physics improves slowly. Is there any part where the recipes should be adjusted? How would this affect the outcome?[1]

Please reach out to Ziggy if you have any questions.

---

[1]See for instance, Temmink et al., Coping with loss: Stability of mass transfer from post-main sequence donor stars (`https://ui.adsabs.harvard.edu/abs/2022arXiv220912707T/abstract`) or El-Badry et al., Magnetic braking saturates: evidence from the orbital period distribution of low-mass detached eclipsing binaries from ZTF (`https://ui.adsabs.harvard.edu/abs/2022MNRAS.517.4916E/`).